Scientific Computing with MATLAB

Ali Khajehesamedini

ali.khajehesamedini@tum.de

Technische Universität München

Wissenschaftszentrum Weihenstephan

Lehrstuhl für Systemverfahrenstechnik

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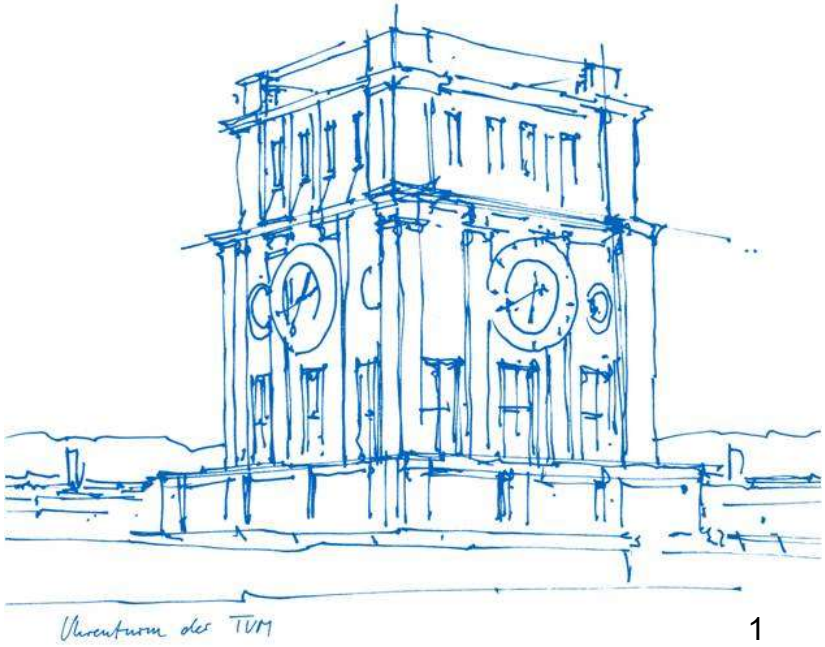


What you'll learn

- ✓ Matrix Labratory (variables, operations, functions, vectors, matrixes)

Workspace

Name	Value	Class
A	*4x4 double*	double
B	[1;2;3;4]	double
filename	'myfile.txt'	char
patient	*1x1 struct*	struct
t	'Hello'	char
val1	*2x3 cell*	cell
val2	[17,21,42]	double
x	325	double
y	[9900,26025,39600]	uint32
z	-Inf	double

Order	Operator	Name
1	( )	Parentheses
2	^	Exponent
3	~	Negation (Logical "NOT")
4	* /	Multiply, Divide
5	+ –	Add, Subtract
6	< > <= >= == ~=	Relational Operators
7	&	Logical "AND"
8	|	Logical "OR"

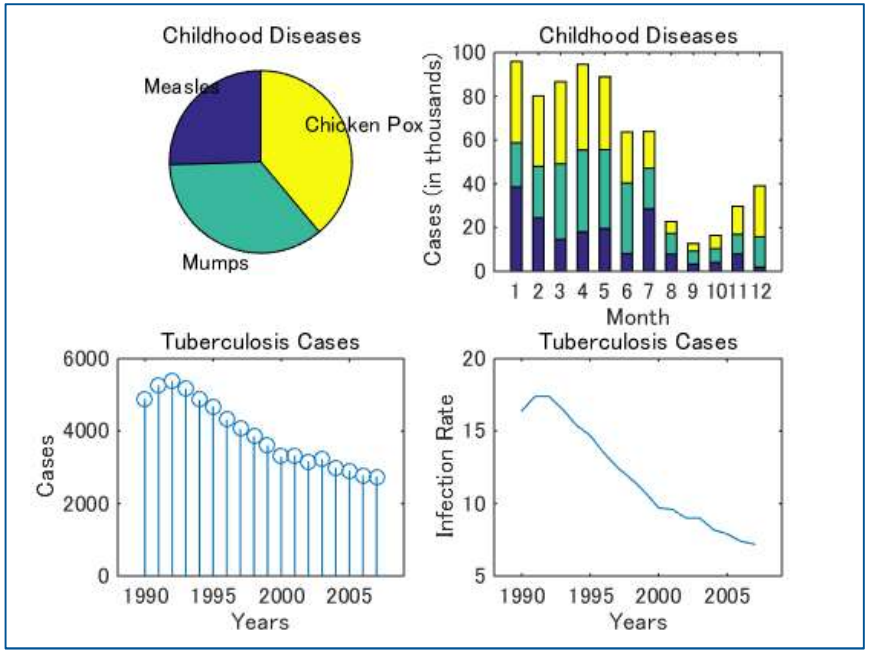
$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ \vdots \\ m \end{array} \begin{array}{c} \begin{array}{cccc} 1 & 2 & \dots & n \end{array} \\ \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ a_{31} & a_{32} & \dots & a_{3n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \end{array}$$

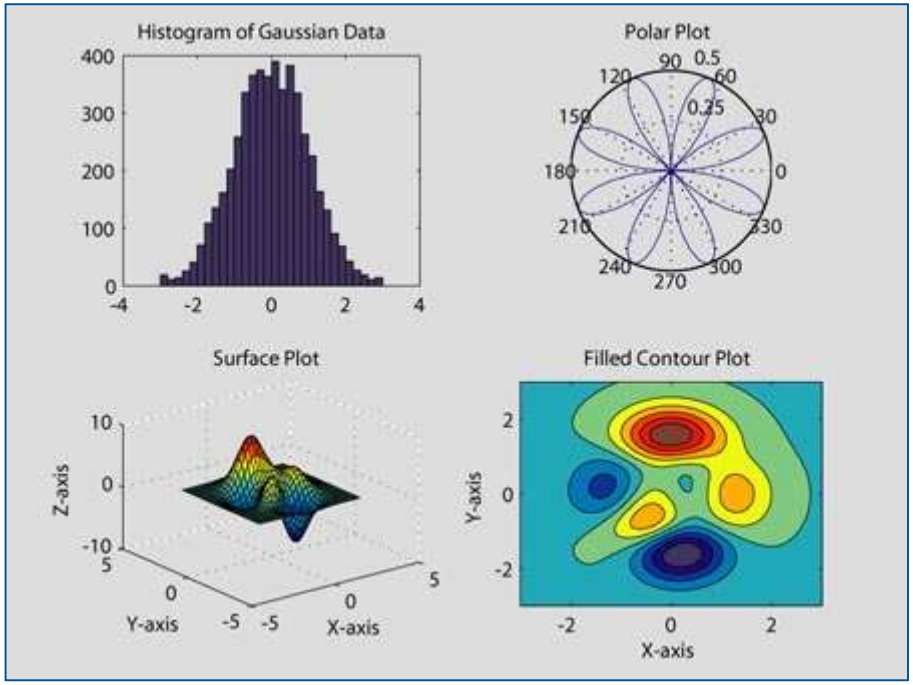
max(x)
min(x)
mean(x)
median(x)
sum(x)
prod(x)
sort(x)

```
function [mean,stdev] = stats(vals)
% #codegen

% calculates a statistical mean and a standard
% deviation for the values in vals.

len = length(vals);
mean = avg(vals,len);
stdev = sqrt(sum(((vals-avg(vals,len)).^2))/len);
```

What you'll learn (con‘t)

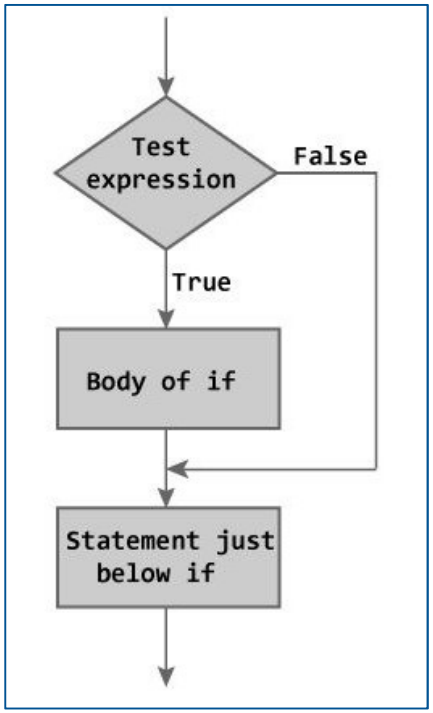
- ✓ Data Visualization (2D & 3D plots)

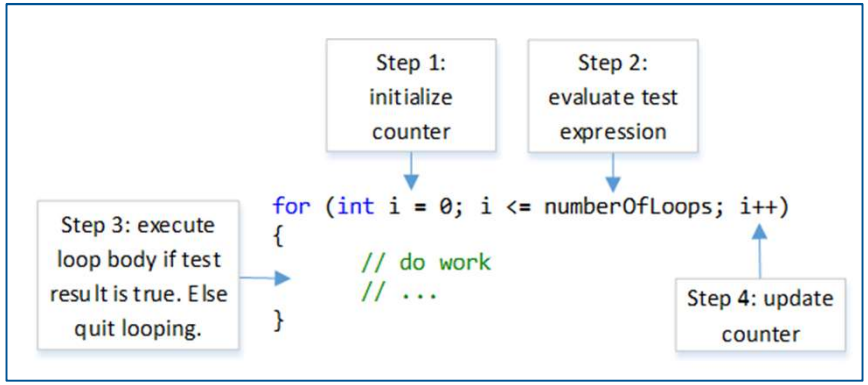


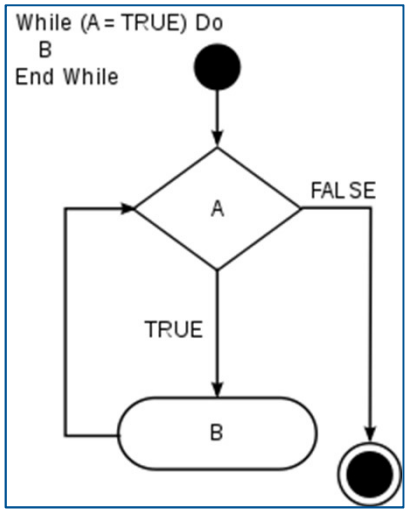


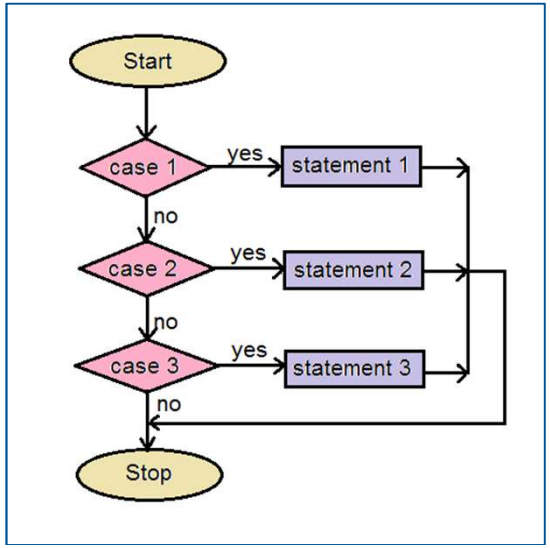
What you'll learn (con‘t)

- ✓ Control flow (if statements, for loop, while loop, switch case)



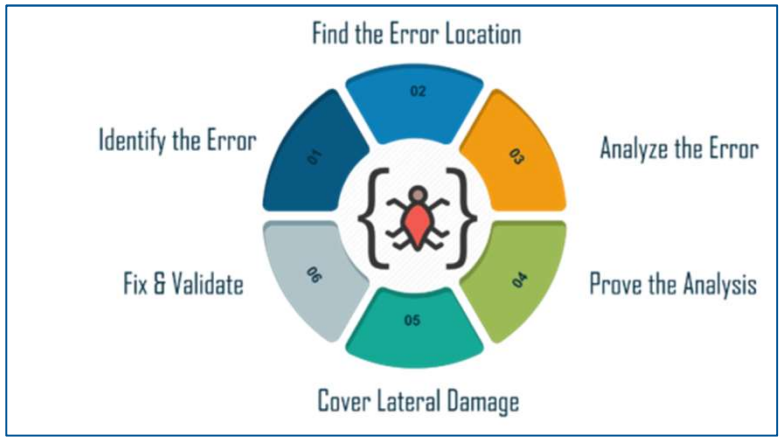


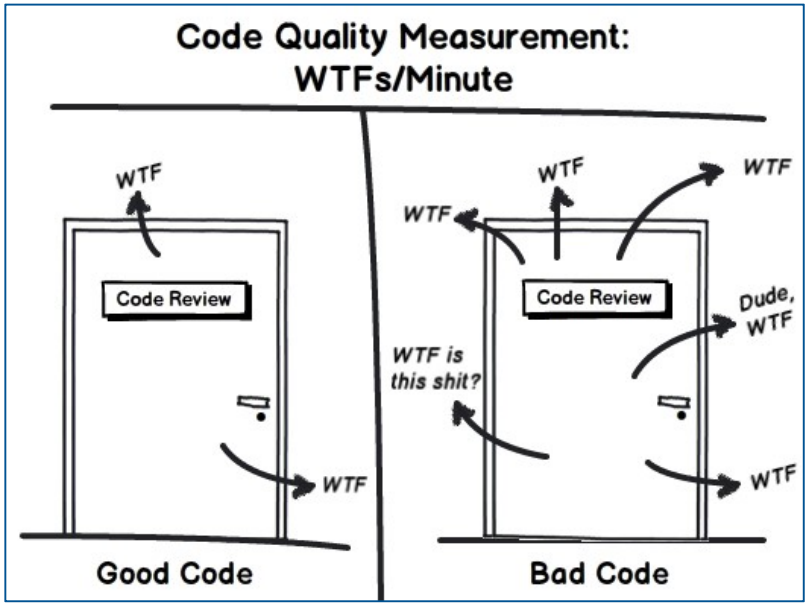


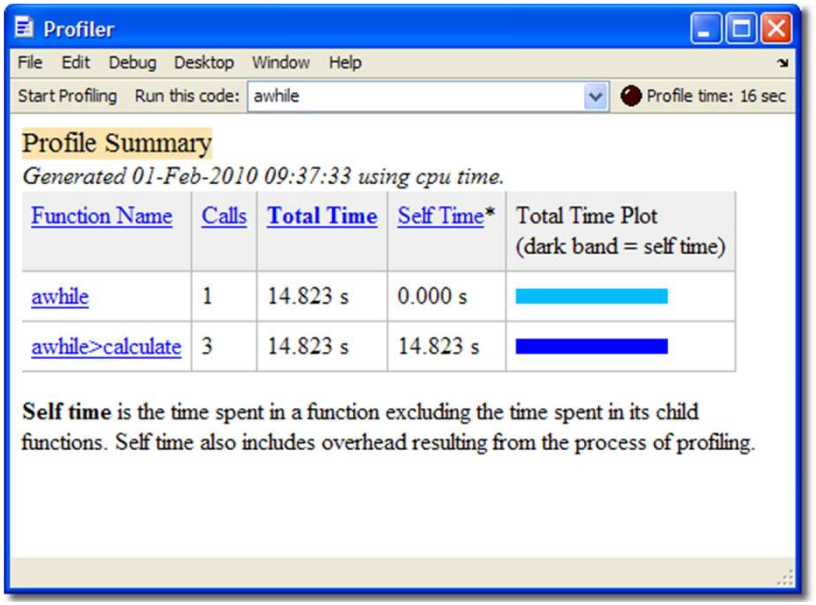


What you'll learn (con‘t)

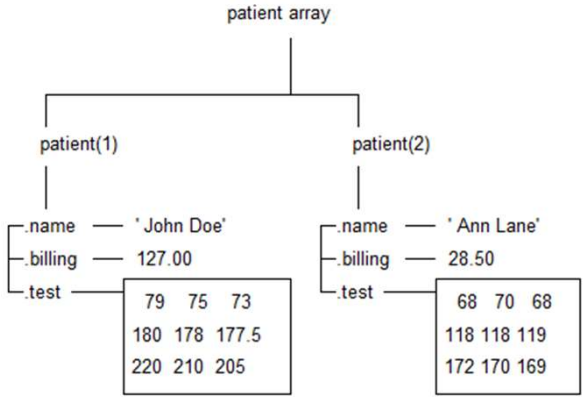
- ✓ Best Practices (code reviewing , debugging)



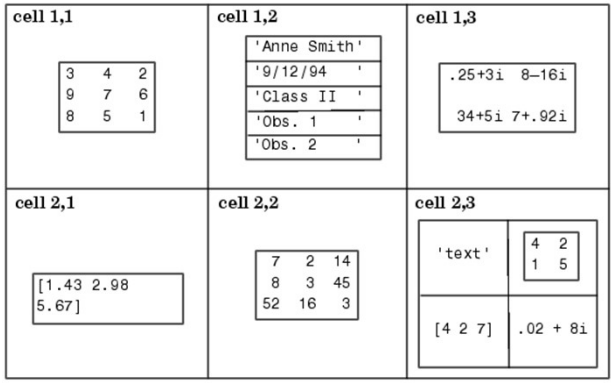




What you'll see



- ✓ Hetrogenuous data types (cell & structs)
- ✓ Working with Tables & TimeTables

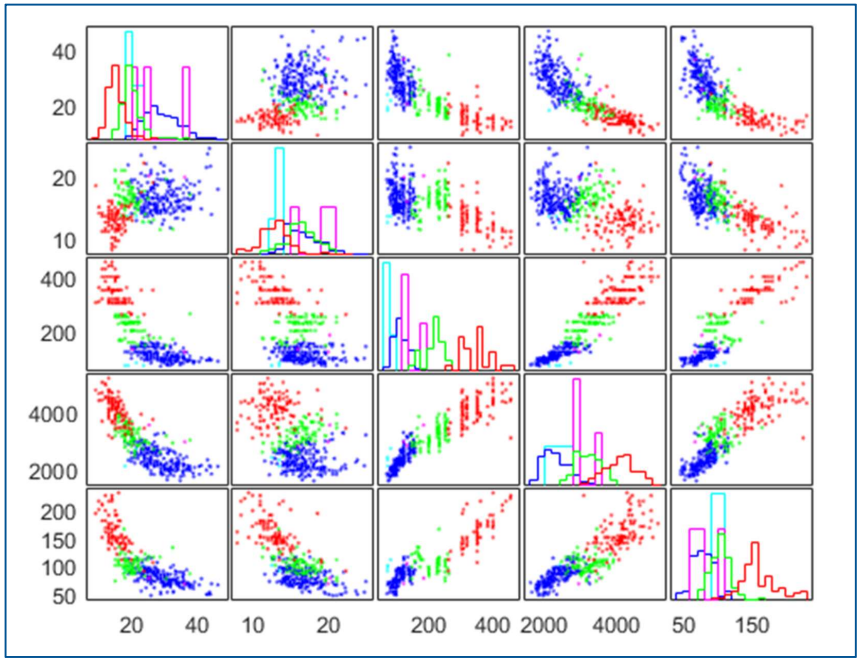


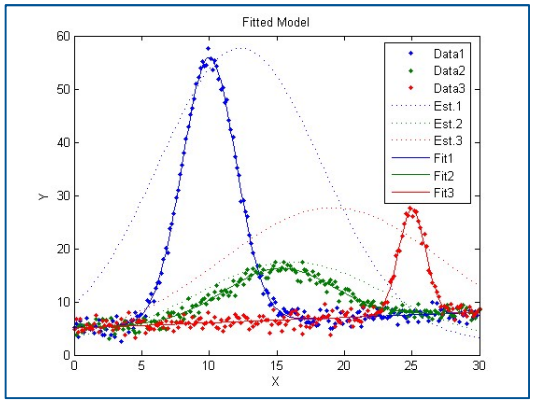
Date	1 Hour	2 Price	3 Volume
01/05/2015	1	-500	35234
01/05/2015	1	-499.9000	35234
01/05/2015	1	-499.1000	35233
01/05/2015	1	-499	35233
01/05/2015	1	-498	35231
01/05/2015	1	-497.9000	35231
01/05/2015	1	-497	35229
01/05/2015	1	-496.9700	35219
01/05/2015	1	-463.3000	35166
01/05/2015	1	-463.2000	35166
01/05/2015	1	-450	35146
01/05/2015	1	-425	34506

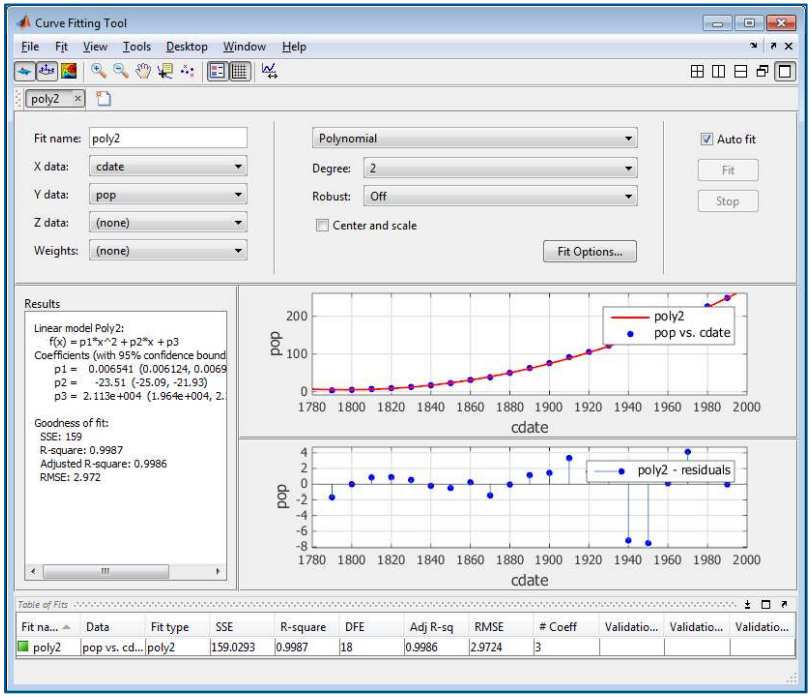
LastName	Age	Weight	Height	Smoker	SelfAssessedHealthStatus
Smith	38	176	71	☑	Excellent
Johnson	43	163	69	☐	Fair
Williams	38	131	64	☐	Good
Jones	40	133	67	☐	Fair
Brown	49	119	64	☐	Good
Davis	46	142	68	☐	Good
Miller	33	142	64	☑	Good
Wilson	40	180	68	☐	Good

What you'll learn (con‘t)

- ✓ Statistics & Data Analysis (curve fitting, analysis of corrolation)







What you'll learn (con‘t)

- ✓ Solving Algebraic Equations
- ✓ Solving Ordinary Differential Equations
- ✓ Solving Differential Algebraic Equations

$$\begin{cases} 4x + 2y = 8 \\ 5x + 3y = 9 \end{cases}$$

Nonlinear System

$$3x^2 + 3y^2 = 27$$

$$3x^2 + 2y^2 = 23$$

Initial value problems (IVP)

An initial value problem is an ODE together with some initial value.

Example

$$\begin{cases} y' = y + 1 \\ y(0) = 5 \end{cases}$$

Solution

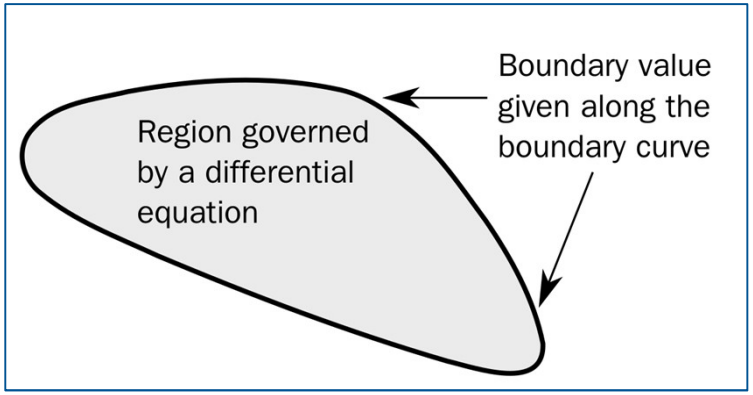
- General solution to $y' = y + 1$ is $y(x) = C e^x - 1$

$$\begin{aligned} \frac{dx}{dt} &= x + 2y \\ \frac{dy}{dt} &= 3x + 2y \end{aligned} \quad \text{with} \quad \begin{cases} x(0) = 6, \\ y(0) = 4. \end{cases}$$

$$\begin{aligned} Y(t) &= A(t)\, K(t)^{\frac{1}{3}}\, Ly(t)^{\frac{2}{3}} \\ \frac{d}{dt} K(t) &= s\, Y(t) - d\, K(t) \\ \frac{d}{dt} A(t) &= z\, A(t)\, La(t) \\ Ly(t) + La(t) &= L \\ La(t) &= l\, L \end{aligned}$$

What you'll learn (con‘t)

- ✓ Boundary Value Problems
- ✓ Partial Differential Equations



$$u^{(2)}(x) + 4\,u^{(1)}(x) + 7x\,u(x) = \sin(x)$$
$$u(2) = 1.5$$
$$u(3) = 2.5$$

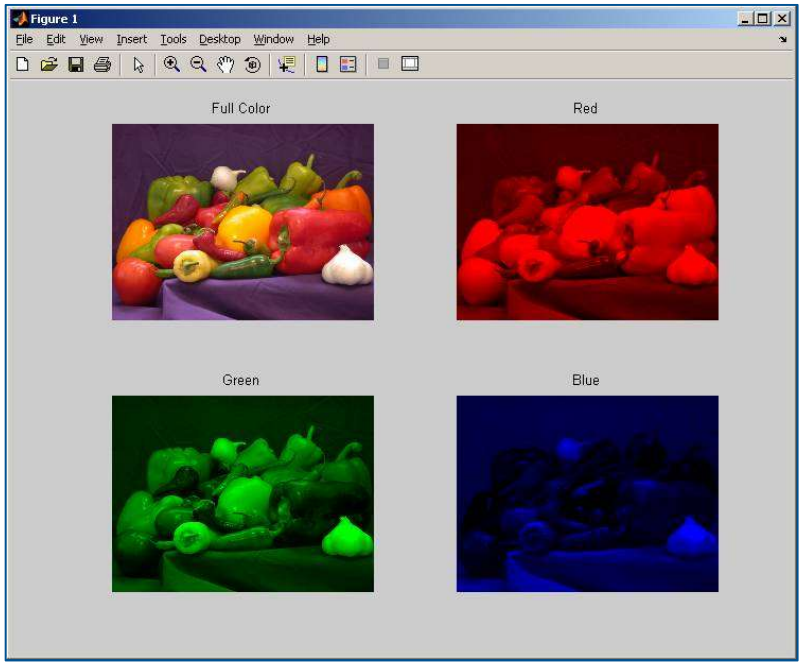
$$\frac{\partial^2 u1}{\partial t^2} - 676000\frac{\partial^2 u1}{\partial x^2} = 0$$
$$\frac{\partial^2 w1}{\partial t^2} + 65.12\ \frac{\partial^4 w1}{\partial x^4} = 0$$

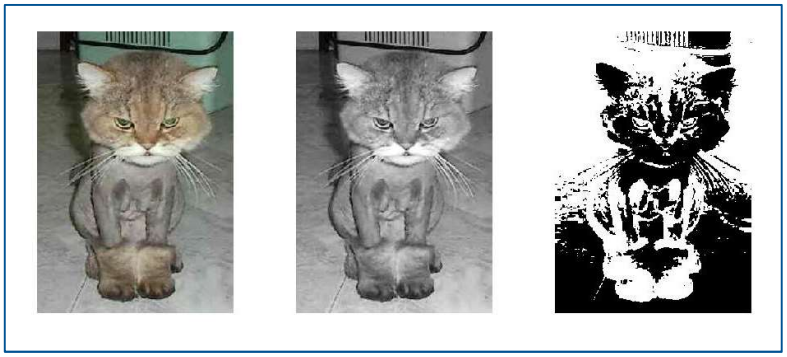
Coupled partial differential equation,

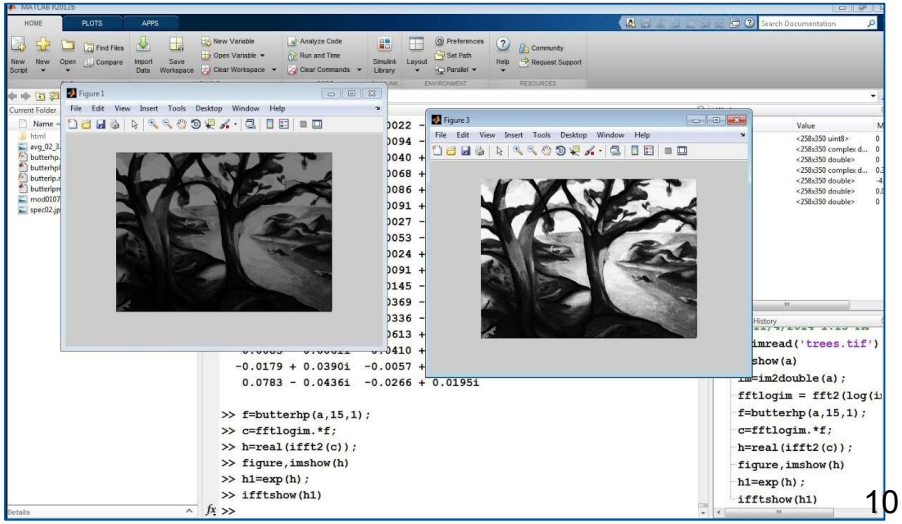
$$\frac{\partial^2 u2}{\partial t^2} - 374004\frac{\partial^2 u2}{\partial x^2} - 1906\ \frac{\partial^3 w2}{\partial x^3} = 0$$
$$\frac{\partial^2 w2}{\partial t^2} + 1900\frac{\partial^3 u2}{\partial x^3} + 67.38\ \frac{\partial^4 w2}{\partial x^4} = 0$$

What you'll learn (con‘t)

- ✓ Image Processing (RGB, Gray, B&W; image filtering)







Premise of the course

- Who should attend

  Students who are passionate about data analysis & programming (experimentalists & modeling gurus)

- Requirements

  Fundamental knowledge of engineering mathematics

- Style of teaching

  First, showing Big-Picture in slides

  Then, programming in “Matlab live editor“ to see the results next to the code (practical examples/exercises from life science technologies)

Premise of the course (con‘t)

- How to attend the sessions

  TUM zoom (links are provided in the TUM Moodle)

- Time of the sessions (14+12)

  Lectures: Wednesdays 14:00 – 15:30 (first session 14.04.21)

  Solving exercises: Mondays 14:00 - 15:00 (first session 19.04.21)

- How to access the content

  TUM Moodle (recorded sessions & slides/filled notebooks/exercises in the Matlab Drive)

- Evaluation

  30min oral exam (can be done in EN/DE/ES/PT)

Schedule

Teaching	Exercise Solving	Content
01.S: Wed 14.04	01. Mon 19.04	Matrix Laboratory
02.S: Wed 21.04	02. Mon 26.04	Data Visualization
03.S: Wed 28.04	03. Mon 03.05	Control Flows
04.S: Wed 05.05	04. Mon 10.05	Best practices
05.S: Wed 12.05	05. Mon 17.05	Advanced Data type I
06.S: Wed 19.05		Advanced Data type II
07.S: Wed 26.05	07. Mon 31.05	Data Analysis
08.S: Wed 02.06	08. Mon 07.06	Curve Fitting, Solving AE
09.S: Wed 09.06	09. Mon 14.06	Solving ODE, DAE
10.S: Wed 16.06	10. Mon 21.06	Solving BVP, PDE
11.S: Wed 23.06	11. Mon 28.07	Image Processing I
12.S: Wed 30.06	12. Mon 05.07	Image Processing II
13.S: Wed 07.07	13. Mon 12.07	Practice Makes Perfect
14.S: Wed 14.07		Practice Makes Perfect

Thank you for your attention

Looking forward to our first session on Wednesday 14th April at 14:00